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(54) **Video camera having focusing and image-processing function**

Videokamera mit Zoom- und Bildverarbeitungsfunktion

Caméra vidéo pourvue de fonction de zoom et de traitement d'image

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(56) References cited:
DE-A- 3 905 619 **US-A- 4 404 594**

- **PATENT ABSTRACTS OF JAPAN vol. 12, no. 276 (P-737)1988 & JP-A-63 056 622**
- **PATENT ABSTRACTS OF JAPAN vol. 12, no. 300 (P-745)1988 & JP-A-63 073213**
- **PATENT ABSTRACTS OF JAPAN vol. 11, no. 181 (P-585)1987 & JP-A-62 011 836**
- **PATENT ABSTRACTS OF JAPAN vol. 13, no. 453 (E-831)1989 & JP-A-11 75 456**
- **PATENT ABSTRACTS OF JAPAN vol. 10, no. 300 (P-506)1986 & JP-A- 61 116 313**

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Description

The present invention relates to a video camera and, more particularly, to a video camera having an improved "auto-focus scheme", capable of obtaining an in-focus image of an object moving at high speed, and having a image-processing function for the in-focus image.

Conventional auto-focus schemes for a video camera are mainly classified into an "active scheme" and a "passive scheme" in accordance with whether a search signal serving as a distance measurement reference is output (emitted) or not.

The active scheme emits, e.g., an ultrasonic wave or an infrared ray and receives the wave or ray reflected by an object. To the contrary, the passive scheme determines an object distance in accordance with only a video signal.

In these two types of auto-focus schemes, automatic focusing is performed such that an in-focus decision signal is obtained from any means, and a focusing lens or the like is moved by a motor in accordance with a drive signal corresponding to this decision result.

In such a conventional scheme, a focusing operation is performed after the in-focus state is decided, and the motor speed determines the focusing speed. Therefore, the focusing speed is limited, and an error often occurs in focusing on an object moving at a high speed.

In an image picked up by fixing the focal position after an in-focus state is obtained, it can be kept in the in-focus position within a normal depth of field (i.e. focal depth of image), but is set in a defocus state in a range falling outside the normal depth of field. Therefore, an image focused in a larger depth of field cannot be obtained.

In recent years, the importance of security in a variety of fields has been increasing along with the development of an information-oriented society. As an example, an image surveillance system used to detect an intruder or the like is available. When the number of surveillance areas checked by operators on monitors is increased, the operators who always check the monitors are overloaded, and reliability is degraded. Strong demand, therefore, has arisen for providing an automatic image surveillance system.

When a moving robot is to be designed, a technique for detecting a moving object from instantaneously changing scenes obtained by a moving image pickup system is required. There are recently provided some systems for performing automatic surveillance using TV cameras. In these systems, a still image of an environment is picked up as a background image. Differences between this background image and time-serially obtained images are sequentially obtained, and a total sum of change amounts in a predetermined area is obtained. The total sum is compared with a threshold value to decide "intrusion" within the field of view.

According to this scheme, in an environment where an illuminance varies as in an outdoor condition and a condition under fluorescent illumination, the brightness of the background area is changed due to variations in illumination. For this reason, it is difficult to separate and detect a change caused by an intrusion object, thereby degrading system reliability. According to this scheme, only the presence of an intrusion object is detected. Information representing the direction of movement of the intrusion object cannot be obtained. In addition, when the field of view is always changing as in a moving robot, the background area is also moved. Therefore, intrusion decision cannot be performed by only direct differences.

In order to solve various problems described above, the optical flow in a target area is obtained from a time-serial image, and the background area is separated from the intrusion object on the basis of the optical flow, thereby performing highly reliable detection. Extensive studies have been made for a fundamental technique in this scheme as motion analysis in the fields of computer visions since late 1970.

The techniques conventionally subjected to the above extensive studies are classified into a "gradient-based technique" using spatial and time changes in image densities and a "feature-based technique" for extracting features (characteristics) such as edges from an image and estimating a movement amount from a correlation result between the corresponding features in images having a time difference. The former technique has an advantage in that a movement amount with respect to an image as a whole can be obtained. However, since this technique uses a differential calculation, precision is greatly degraded by noise mixture in an image. In addition, estimated values for a coarse texture area and a boundary object area become inaccurate. The latter scheme has inaccurate movement amounts because feature values are used. However, degradation of precision by noise can be minimized in the latter technique.

In either technique, since time differences and positional differences (the latter differences are typical in the case of moving robot applications) are large using a time-serial image directly obtained by a conventional TV camera, it is difficult to set ranges corresponding to differential calculations and feature values. A highly reliable optical flow cannot be obtained, and almost no practical applications have been made.

As described above, in auto-focus schemes of the conventional image surveillance apparatuses and video cameras, an increase in focusing speed is limited by its structural characteristics, and at the same time an error occurs in an object moving at high speed. In addition, it is difficult to obtain a clear in-focus image in the range from the infinite position to the closest position (i.e., a wide range in the direction of the depth of field) in the entire image pickup area.

When a time-serial image picked up by the conventional image pickup apparatus is used, time and positional differences are large, and a highly reliable optical flow is difficult to obtain.

A servo-mechanism for positioning an image pickup device in different image pickup planes, each image signal being stored in frame memories and the part having the maximum space frequency being discriminated is disclosed by Patent Abstracts of Japan, vol. 11, no. 181 (P-585) 1987, JP-A-62 011 836.

Oscillation at high speed in the direction of the optical axis using a piezoelement of an image pickup element is described in Patent Abstracts of Japan, vol. 12, no. 300 (P-745) 1988, JP-A- 63 073 213.

DE-A-3 905 619 describes motion generating means coupled to either the image pickup element or to the lens system.

Automatic focus adjustment by vibrating an image pickup element by a piezoelectric element in optical-axis direction is described in Patent Abstracts of Japan vol. 12, no. 276 (P-737) 1988, JP-A-63 056 622.

It is an object of the present invention to provide an image pickup apparatus such as a video camera capable of increasing a focusing speed and realizing a high-speed auto-focus operation free from operational errors.

It is another object of the present invention to provide a video camera wherein a means for performing an image pickup operation of an image pickup element at an arbitrary position while a lens or the image pickup element is vibrated at a predetermined period in a direction of an optical axis is used, a time-serial image having small time and positional differences is obtained, and a highly reliable optical flow is obtained, thereby providing a highly precise image surveillance function by using the highly reliable optical flow.

According to a first aspect of the present invention there is provided a video camera comprising:
a video camera body having an image pickup element for picking up optical information incident on a lens system; and

vibration generating means, mechanically coupled to said image pickup element, for applying a vibration to said image pickup element with a predetermined stroke of amplitude in a direction of an optical axis and causing said image pickup element to perform image pickup operations at a plurality of positions; wherein
said vibration generating means comprises:
a vibration drive source, mechanically coupled to said lens system or said image pickup element, for applying a vibration drive force to at least one of said lens system and said image pickup element, and
vibration source control means for applying a predetermined control signal to said vibration drive source to generate a vibration at a predetermined period; and
said vibration source control means comprises an actuator control circuit, and
said vibration drive source comprises a piezoelectric actuator,
said piezoelectric actuator being constituted by two cantilevered bimorph structures each consisting of a plurality of S-shaped driven bimorph elements.

According to a second aspect of the present invention there is provided a video camera comprising:

an image pickup element for receiving optical information of an object to be photographed after the optical information passes through a lens system, and performing an image pickup operation;
vibration generating means, mechanically coupled to said image pickup element, for applying a vibration to said image pickup element with a predetermined stroke of amplitude in the direction of the optical axis;
sampling means for extracting image signals at predetermined time intervals from a plurality of image signals of different focal positions obtained from said image pickup element at a plurality of positions within the stroke; and
image memory means for time-serially storing sampling images acquired from said image pickup element; wherein said vibration generating means has a vibration drive source comprising a piezoelectric actuator, said piezoelectric actuator being constituted by two cantilevered bimorph structures each consisting of a plurality of S-shaped driven bimorph elements.

Instead of obtaining one image by a "focusing" operation, the image pickup element is always vibrated along the optical axis to perform image pickup operations at a plurality of arbitrary positions (i.e., intermediate positions within the amplitude of the vibration), and at least one image whose focal points are matched is obtained from the plurality of images obtained by the above image pickup operations, thereby extracting and visualizing its clear image.

One arrangement of the video camera according to the present invention comprises an image pickup element, having an auto-focus function, for picking up an optical image obtained through a lens system, means for vibrating the image pickup element at a predetermined period in a direction of an optical axis, and for causing the image pickup element to perform image pickup operations at a plurality of arbitrary positions, and means for extracting a predetermined image signal from the plurality of image signals of different focal positions obtained by the image pickup element.

The means for extracting the predetermined image signal employs the following techniques:

(1) a technique for extracting an image signal having highest in-focus precision from the plurality of image signals of the different focal positions; and
(2) a technique for dividing each of the plurality of image signals into a plurality of areas, performing focus detection in units of divided areas, and ex-

tracting divided areas (image signals) corresponding to highest in-focus precision from the areas and synthesizing the extracted areas.

The vibration period of the image pickup element is preferably synchronized with a frame period of an image signal.

Furthermore, a piezoelectric actuator is used as a drive source for driving the image pickup element.

The video camera according to the present invention is arranged as its application in the following manner.

Another arrangement of this video camera comprises means for picking up an optical image obtained through a lens system, means for vibrating a lens or an image pickup element at a predetermined period in a direction of an optical axis and for causing the image pickup element to perform image pickup operations at arbitrary positions, means for extracting an optical flow from a plurality of images obtained from the image pickup element, and means for detecting a moving object by using the optical flow, wherein time-serial images obtained by linearly vibrating the image pickup element or the lens in the direction of the optical axis are accumulated, an optical flow between the accumulated time-serial images is obtained, and motion vector strings obtained by connecting the corresponding vectors are separated into motion vector strings having FOE (Focus Of Expansion) points by the above vibration and motion vector strings without FOE points, thereby detecting an intrusion object.

Image pickup operations are performed while the image pickup element is always vibrated along the optical axis. Video signals obtained in the vibrated state of the image pickup element are processed in accordance with a predetermined sequence. Therefore, "high-speed focusing" operations can be performed, and at the same time, an image having a wider focal range from the infinite position to the closest position (i.e., a wide range in the direction of the depth of field of the object) can be obtained.

A practical technique for obtaining the above image signal is as follows.

An image signal is sampled at a plurality of arbitrary points during movement of the image pickup element, and only an image having highest in-focus precision is output and visualized. By using this highly precise image, predetermined image processing is performed while the vibration period of the image pickup element is synchronized with the frame period of the image signal, thereby always obtaining an in-focus motion image. In addition, the technique for processing the sampled images is changed to obtain an in-focus image in the wider range from the infinite position to the closest position.

According to another technique, the vibration period of the image pickup element is synchronized with the frame period of the image signal so that the image reception positions are set identical to each other. Electronic auto-focus control is performed while the image reception positions or its setup are synchronized with the focus signals, thereby always obtaining an in-focus motion image.

In another video camera according to the present invention, images are input while the lens or the image pickup element is vibrated to obtain time-serial images having small time and positional differences. As a result, "correlation search" can be easily performed. The highly precise optical flow can be obtained although this cannot be obtained by images picked up by the conventional image pickup element. In addition, vibration linearity can be precisely controlled, so that precision of FOE measurement can be improved. Therefore, the background can be separated from the motion of the moving object, thereby obtaining a highly precise image.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a diagram showing a schematic arrangement including a section of the main part of a video camera along a direction of an optical axis according to an embodiment of the present invention;

Figs. 2A to 2C are views showing an arrangement of a video camera body and a piezoelectric actuator used in the embodiment of the present invention;

Fig. 3 is a graph showing a relationship between the position and time of an image pickup element of the video camera described above and the distance to an object;

Figs. 4A and 4B are views showing states of image extraction in the embodiment;

In the schematic arrangement of a video camera according to the present invention, as shown in Fig. 1, a lens system 10 comprises a focusing lens 11 which is used in focusing but is not moved in zooming, a zoom lens 12 moved to change the size of an image formed by the focusing lens 11, a focal position correction lens 13 called a "compensator" moved to maintain an image formation position constant, and a relay lens or condenser lens 14. Each of these lenses 11 to 14 comprises a plurality of lenses. The lens system 10 comprise four groups of lenses.

A low-pass filter 15 is located behind the lens system 10. An image pickup element 20 is located behind the low-pass filter 15 to pick up an optical image. Optical information of an object to be photographed or the like is incident on the image pickup element 20 through the lens system 10 and is picked up (photo-electrically) by the image pickup element 20.

The image pickup element 20 is always vibrated with a stroke (amplitude) of about 3 mm in a direction of an optical axis by a vibration generation system 100 including a piezoelectric actuator 70. This stroke value is a value required to perform focusing upon movement of

the image pickup element from the infinite position to the closest position of 1 m in an 1/2" optical system with zooming having a magnification of 6. A position x∞ of the image pickup element 20 corresponding to a distance ∞ to the object is assumed to represent a position of the image pickup element closest to the lens system 10. A position x1m of the image pickup element 20 corresponding to a distance of 1m to the object is assumed to represent a position of the image pickup element 20 farthest from the lens system 10. During the operation, the image pickup element 20 is vibrated between the above two points (stroke) to obtain a plurality of image signals.

A plurality of time-serial image signals obtained by the image pickup element 20 are input to an image input system 200 for sequentially processing these plurality of image signals. Each input image signal is input to an image signal processing circuit 22 connected to the image pickup element 20 and is subjected to processing such as A/D conversion. Thereafter, the precessed image signal is temporarily stored in an image field (i.e., frame) memory 35 (in units of time-serial signals). In-focus states of the plurality of converted image signals are detected by an in-focus decision circuit 24 connected to the image signal processing circuit 22 in units of images. The clearest image is selected from the plurality of image signals as a result of this detection. Desired images are partially extracted by, e.g., an image synthesizing circuit 26, as needed, and are synthesized as one image in an output image memory 60 by synthesis processing. The synthesized image is finally displayed and output on a screen 80.

A motor 50 in Fig. 1 constitutes an auto-zoom mechanism for driving the zoom lens 12 through a pinion and a worm gear in the direction of the optical axis to change a focal length.

A normal operating shape of the piezoelectric actuator 70 is shown in Fig. 2A, and deformed shapes during its operations are shown in Figs. 2B and 2C.

A predetermined control signal having a magnitude falling with the range of qV is applied from an actuator control circuit 73 to the piezoelectric actuator 70 to always vibrate the image pickup element 20 in the direction of the optical axis in Figs. 2A to 2C. The stroke (vibration) of the piezoelectric actuator 70 is about 3 mm with respect to the object in the range from the infinite position to the closest position of 1 m in the 1/2" optical system with zooming having a magnification of 6. The image pickup element 37 obtains images of object positions corresponding to positions within this stroke. These image signals are supplied (input) to the image input circuit system 200.

The lens system 10 comprises 4 lens groups consisting of the focusing lens 11, the zoom lens 12, the focal position correction lens 13, and the relay lens 14. The low-pass filter 15 is located behind the lens system 10. An optical image is formed on the image pickup plane of the image pickup element 20 such as a CCD through the lens system 10 and the low-pass filter 15.

The piezoelectric actuator 70 is mounted on the side of the image pickup element 20 opposite to its image pickup plane to move the image pickup element 20 in the direction of the optical axis. The piezoelectric actuator 70 comprise S-shaped driven bimorph elements 71a to 71f. These S-shaped driven bimorph elements are elements driven so that displacement directions of each bimorph element have opposite phases with respect to the center along the longitudinal direction. In the illustrated arrangement, two structures each consisting of three S-shaped driven bimorph elements (71a to 71c or 71d to 71f) connected in series with each other constitute cantilevered bimorph structures. When free ends of these two cantilevered bimorph are connected, the displacement is increased and the mechanical characteristics are improved.

Another pair of cantilevered bimorph structures are prepared as in the bimorph elements 71a to 71f, as indicated by the alternate long and two short dashed lines, thereby further improving the mechanical characteristics.

A graph in Fig. 3 shows an operation of a "high-speed focusing" operation. Axial movement of the image pickup element 20 is represented by a polygonal line. The position x of the image pickup element (range: infinite to 1 m) is plotted along the abscissa of this graph, and time t (required to obtain an in-focus state) is plotted along the ordinate. A plurality of images corresponding to a plurality of arbitrary positions are sampled within the movement range of the image pickup element 20. In this embodiment, the image pickup element 20 performs sampling several times (5 times in this embodiment). Driving of the image pickup element 20 by the movement actuator is set so that the image pickup element is stopped for a sampling (predetermined) time or more. Note that if the sampling (predetermined) time is sufficiently shorter than the movement time of the image pickup element 20, the stop time need not be provided.

As shown in Fig. 4F, a plurality (five in this embodiment) of images are obtained during sampling between x∞ to x1m. High-frequency components of the image signals of these images are extracted and integrated to detect "focal point evaluation values" for detecting the degrees of focusing (i.e., focusing precision: in-focus precision). Comparison is performed in units of images. Of these images, one image having highest in-focus precision is selected and is output as an image. More specifically, the vibration period of the image pickup element 20 is synchronized with the frame period of the image signal. For example, in the NTSC (National Television System Committee) scheme, when a moving speed between x∞ and x1m is set to be 1/60 sec., one reciprocal stroke (i.e., one period of the vibration) corresponds to one frame in the NTSC scheme. As a result, a motion image is always obtained in an in-focus state.

A video camera as an imaging apparatus suitable for an application in which an in-focus image is obtained

on the entire screen if so desired further comprises the image synthesizing circuit 26 for performing image synthesis processing.

More specifically, during each movement cycle between x∞ and xlm, the image synthesizing circuit 26 divides each sampling image into a plurality of areas, as shown in Fig. 4B, and focus detection is performed in units of divided areas. During one movement cycle between x∞ and x1m, only in-focus areas are extracted from the memory 35 to synthesize them into one image. Therefore, an image (e.g., a motion image) having an extremely large depth of field, i.e., an in-focus image in the entire range from the infinite position to the closest position can be obtained.

In place of the above "extraction and synthesis technique", "filtering processing" for filtering a blur portion in each image or an "omission and synthesis technique" for omitting blur portions of the images and synthesizing the resultant images may be employed.

Another arrangement of "high-speed focusing" operation will be described below. As in the previous embodiment, the image pickup element 20 is vibrated in synchronism with the frame period of the image signal. The reception time of the image signal forming one frame is set sufficiently shorter than the vibration period, and only image signals at given focal positions within the vibration range are read. Since the vibration period coincides with the frame period, the read position can be electronically and arbitrarily controlled. A focal point evaluation value is detected from the read image signal, and the read position is fed back, thereby performing auto-focus processing. Since the auto-focus feedback system can be constituted by only electronic circuits, in-focus motion images can always be obtained.

The image signals obtained during movement between two points falling within the range of x∞ and x1m are received and displayed. For example, when a display operation is performed every 30 frames/sec as in the NTSC scheme, an image is obtained such that images overlap from an image of the closest position to an image of the infinite position. Although image quality is slightly degraded, this scheme can provide an in-focus image in a wide range from the infinite position to the closest position. Therefore, a clear object having a high contrast level can be sufficiently recognized. A better image can be obtained when image processing is performed.

The above description exemplifies a technique for obtaining an in-focus image within a field. The image pickup element 20 need not be operated at very high speed (e.g., vibration in this case), and any scheme may be employed if an appropriate in-focus image is obtained by simpler processing.

Various changes and modifications may be made without departing from the scope of the present invention.

The above embodiment according to the present invention can cope with an object or the like which is moving at high speed in a wider range of the depth of field, which operation has not been made by a conventional video camera with an auto-focus mechanism. There is therefore realized a video camera having a high focusing speed capable of obtaining an in-focus image at a higher speed in accordance with predetermined image processing.

The present invention is applicable as a modification to a system including an image apparatus having a moving field of view as in a moving robot in addition to an arrangement in which the field of view is stationary and the image pickup plane vibrates, if the moving direction is regarded as a linear direction. In this modification, a point for generating a motion vector string of the background area is not an FOE point generated by the vibration of the image pickup plane, but an FOE position obtained upon vibration of the image pickup plane in a third direction obtained by synthesizing the moving direction of the moving robot and the vibration of the image pickup plane. If the vibration speed is sufficiently higher than the speed of the moving robot, the FOE position almost coincides with the FOE point generated by only vibration of the image pickup plane.

In addition, when the motion vector string of the intrusion object is analyzed, its moving direction can be detected.

Various changes and modifications may be made without departing from the scope of the invention.

A highly reliable optical flow is obtained from time-serial images having small time and positional differences obtained upon vibration of a lens or image pickup element at a predetermined period in a direction of an optical axis, and image processing is performed to separate the movement of the background from that of the moving object by using the optical flow, thereby obtaining a high-quality image. By changing a sampling image processing technique in image processing in accordance with an application purpose, in-focus motion images throughout the entire range from the infinite position to the closest position can be picked up. For example, the present invention can be applied to a variety of applications such as an image surveillance apparatus (e.g., an intrusion surveillance camera) which always requires in-focus images.

In addition, intrusion detection can be performed while the field of view is always moving as in a moving robot, which detection cannot be performed by conventional direct differences. That is, by analyzing the motion vector string of the intrusion object to detect the moving direction, actions such as a collision preventive action and an emergency stop in operations of the robot can be appropriately selected, thus providing a variety of applications and advantageous effects.

Claims

1. A video camera comprising:

a video camera body (1) having an image pickup element (20) for picking up optical information incident on a lens system (10); and

vibration generating means (100), mechanically coupled to said image pickup element, for applying a vibration to said image pickup element with a predetermined stroke of amplitude in a direction of an optical axis and causing said image pickup element to perform image pickup operations at a plurality of positions; characterised in that
said vibration generating means (100) comprises:
a vibration drive source (70), mechanically coupled to said lens system (10) or said image pickup element (20), for applying a vibration drive force to at least one of said lens system and said image pickup element, and
vibration source control means (73) for applying a predetermined control signal to said vibration drive source to generate a vibration at a predetermined period; and
said vibration source control means (73) comprises an actuator control circuit, and
said vibration drive source (70) comprises a piezoelectric actuator,
said piezoelectric actuator being constituted by two cantilevered bimorph structures each consisting of a plurality of S-shaped driven bimorph elements (71a - 71f).

2. A video camera comprising:

an image pickup element (20) for receiving optical information of an object to be photographed after the optical information passes through a lens system, and performing an image pickup operation;
vibration generating means (100), mechanically coupled to said image pickup element, for applying a vibration to said image pickup element with a predetermined stroke of amplitude in the direction of the optical axis;
sampling means (22) for extracting image signals at predetermined time intervals from a plurality of image signals of different focal positions obtained from said image pickup element at a plurality of positions within the stroke; and
image memory means (35) for time-serially storing sampling images acquired from said image pickup element; characterised in that said vibration generating means (100) has a vibration drive source (70) comprising a piezoelectric actuator, said piezoelectric actuator being constituted by two cantilevered bimorph structures each consisting of a plurality of S-shaped driven bimorph elements (71a-71f).

3. A video camera according to claim 2, characterised by further comprising:
in-focus decision extracting means (24) for extracting a high-frequency component from an image signal of the sampling image, detecting a focal point evaluation value for evaluating a degree of focusing upon integrating processing, comparing the focal point evaluation values of the plurality of images, and selecting a sampling image having a largest focusing precision value.

4. A video camera according to claim 2, characterized by further comprising:
image synthesizing means (26) for dividing the sampling image into a plurality of areas performing focus detection in each divided area, and extracting only in-focus areas from said image memory means to synthesize the in-focus areas into a single image.

5. A video camera according to claim 2, characterised by including:

said lens system (10) for focusing optical information of an object to be photographed or the like;
said image pickup element (20) for performing electrical image pickup operations;
said vibration generating means (100) for vibrating said image pickup element itself, or part or all of said lens system with a predetermined amplitude at a predetermined period in a direction of an optical axis;
an image input system (200), connected to said vibration generating means, for performing predetermined information conversion processing for processing an image output; and
said image memory (35) for storing the image output;
further including a CPU (90) for controlling the image processing, a control bus (9) connected to said CPU to transmit a control signal from said CPU, and an image bus (8) for transmitting image information,
wherein said control bus is connected to:
an optical flow detecting system (300) for detecting features and similarity points of the image;
an optical flow memory (65) for storing information associated with the optical flow for surveillance processing;
a Focus of Expansion, abbreviated FOE, measuring circuit system (400) for measuring an FOE point from which the optical flow of a stationary object in the image is generated; and
an intrusion decision circuit system (500) for detecting an intrusion object.

6. A video camera according to claim 5, characterised in that:

said image input system (200) performs predetermined conversion processing of input image information obtained in a half cycle of a vibration period and stores processed information in said image memory through said image bus, and
said image input system (200) comprises:
an A/D converter (6) for converting the image signal output from said camera body (1) into a digital signal; and
an ITV interface (7) for transmitting the digital image signal to said image memory (35).

7. A video camera according to claim 5, characterized in that:

said optical flow detecting system (300) obtains a motion associated with a corresponding area from a plurality of time-serial images prestored in said image memory in accordance with predetermined analysis processing to obtain an optical flow of the corresponding area, and
said optical flow detecting system (300) comprises:
a feature and similarity detector circuit (310) for detecting features and similarity points of the images; and
a feature and similarity detection memory (350) for storing the detection process and a detection result thereof.

8. A video camera according to claim 5, characterised in that:

said FOE measuring circuit system (400) analyzes motions of a background and an object to obtain an optical flow between images of the background and the object, and measures an FOE (Focus of Expansion) point in which an optical flow of a stationary object obtained upon movement of an image pickup plane in a direction of an optical axis is generated from a motion vector string obtained by connecting corresponding vectors of the optical flow, and
said FOE measuring circuit system (400) comprises:
a line detecting circuit (42) for obtaining linear expressions from the motion vector string based on the optical flow by using a predetermined method;
an FOE calculation circuit (44) for obtaining intersections of a plurality of straight lines represented by the linear expressions and calculating coordinates of the FOE point according to a predetermined method; and
an FOE memory (46) for storing the calculated coordinates of the FOE point.

9. A video camera according to claim 5, characterised in that:

said intrusion decision circuit system (500) decides to separate the plurality of images into an image having the FOE point and an image having no FOE point to detect an intrusion object, and
said intrusion decision circuit system (500) comprises:
a decision circuit (52) for determining that the lines obtained by said FOE measuring circuit system (400) pass through the FOE point; and
a parameter memory (56) for storing a predetermined threshold value and the decision result.

Patentansprüche

1. Videokamera mit:

einem Videokamerakörper (1) mit einem Bildaufnahmeelement (20) zum Aufnehmen von optischer Information, die auf ein Linsensystem (10) fällt; und
einer Vibrationserzeugungseinrichtung (100), die mit dem Bildaufnahmeelement mechanisch gekoppelt ist, zum Versetzen des Bildaufnahmeelements in eine Vibration mit einem vorbestimmten Amplitudenhub in einer Richtung einer optischen Achse und zum Bewirken, daß das Bildaufnahmeelement Bildaufnahmevorgänge in einer Vielzahl von Positionen durchführt;

dadurch gekennzeichnet, daß:

die Vibrationserzeugungseinrichtung (100) aufweist:
eine Vibrationsantriebsquelle (70), die mit dem Linsensystem (10) oder dem Bildaufnahmeelement (20) mechanisch gekoppelt ist, zum Aufbringen einer Vibrationsantriebskraft auf mindestens eines, nämlich das Linsensystem oder das Bildaufnahmeelement; und
eine Vibrationsquellensteuereinrichtung (73) zum Anlegen eines vorbestimmten Steuersignals an die Vibrationsantriebsquelle, um eine Vibration mit einer vorbestimmten Periode zu erzeugen; und
die Vibrationsquellensteuereinrichtung (73) eine Antriebsgliedsteuerschaltung aufweist; und
die Vibrationsantriebsquelle (70) ein piezoelektrisches Antriebsglied aufweist;

wobei das piezoelektrische Antriebsglied aus zwei einseitig befestigten bimorphen Strukturen besteht, die jeweils aus einer Vielzahl von S-förmigen angetriebenen bimorphen Elementen (71a-71f) bestehen.

2. Videokamera mit:

einem Bildaufnahmeelement (20) zum Aufnehmen von optischer Information eines zu fotografierenden Objekts, nachdem die optische Information das Linsensystem durchlaufen hat, und zum Durchführen eines Bildaufnahmevorgangs;
einer Vibrationserzeugungseinrichtung (100), die mit dem Bildaufnahmeelement mechanisch gekoppelt ist, zum Versetzen des Bildaufnahmeelements in eine Vibration mit einem vorbestimmten Amplitudenhub in der Richtung der optischen Achse;
einer Abtasteinrichtung (22) zum Extrahieren von Bildsignalen in vorbestimmten Zeitintervallen aus einer Vielzahl von Bildsignalen verschiedener Brennpunktlagen, die von dem Bildaufnahmeelement mit einer Vielzahl von Lagen innerhalb des Hubs abgegeben werden; und
einer Bildspeichereinrichtung (35) zum zeitseriellen Speichern von Abtastbildern, die von dem Bildabtastelement bezogen werden;

dadurch gekennzeichnet, daß:
die Vibrationserzeugungseinrichtung (100) eine Vibrationsantriebsquelle (70) mit einem piezoelektrischen Antriebsglied aufweist, wobei das piezoelektrische Antriebsglied aus zwei einseitig befestigten bimorphen Strukturen besteht, die jeweils aus einer Vielzahl von S-förmigen angetriebenen bimorphen Elementen (71a-71f) bestehen.

3. Videokamera nach Anspruch 2, dadurch gekennzeichnet, daß sie ferner folgendes aufweist:
eine Scharfabbildentscheidung-Extraktionseinrichtung (24) zum Extrahieren einer hochfrequenten Komponente aus einem Bildsignal des Abtastbilds, Ermitteln eines Brennpunktbewertungswertes zum Bewerten eines Grades der Scharfeinstellung bei integrierender Verarbeitung, Vergleichen der Brennpunktbewertungswerte der Vielzahl von Bildern und Wählen eines Abtastbildes mit einem größten Scharfeinstellungsgenauigkeitswert.

4. Videokamera nach Anspruch 2, dadurch gekennzeichnet, daß sie ferner folgendes aufweist:
eine Bildsynthetisierungseinrichtung (26) zum Teilen des Abtastbildes in eine Vielzahl von Bereichen, Durchführen von Brennpunktermittlung in jedem Teilbereich und Extrahieren lediglich von scharf abgebildeten Bereichen aus der Bildspeichereinrichtung, um die scharf abgebildeten Bereiche zu einem einzigen Bild zu synthetisieren.

5. Videokamera nach Anspruch 2, dadurch gekennzeichnet, daß sie folgendes aufweist:

das Linsensystem (10) zur Scharfeinstellung von optischer Information eines zu fotografierenden Objekts oder dgl.;
das Bildaufnahmeelement (20) zum Durchführen von elektrischen Bildaufnahmevorgängen:
die Vibrationserzeugungseinrichtung (100) zum Versetzen des Bildaufnahmeelements selbst oder des gesamten oder eines Teils des Linsensystems in Vibration mit einer vorbestimmten Amplitude bei einer vorbestimmten Periode in einer Richtung einer optischen Achse;
ein Bildeingabesystem (200), das mit der Vibrationserzeugungseinrichtung verbunden ist, zum Durchführen einer vorbestimmten Informationsumwandlungsverarbeitung zur Verarbeitung einer Bildausgabe; und
den Bildspeicher (35) zum Speichern der Bildausgabe;
wobei sie ferner folgendes aufweist: eine CPU (90) zum Steuern der Bildverarbeitung, einen Steuerbus (9), der mit der CPU verbunden ist, um ein Steuersignal von der CPU zu übertragen, und einen Bildbus (8) zum Übertragen von Bildinformation.
wobei der Steuerbus verbunden ist mit:
einem optischen Flußermittlungssystem (300) zum Ermitteln von Merkmalen und Ähnlichkeitspunkten der Bilder;
einem optischen Flußspeicher (65) zum Speichern von Information, die mit dem optischen Fluß zur Überwachungsverarbeitung verbunden ist;
einem Dehnungsbrennpunkt- bzw. FOE-Meßschaltungssystem (400) zum Messen eines FOE-Punktes, von dem der optische Fluß eines stationären Objekts im Bild erzeugt wird; und
einem Eindringentscheidung-Schaltungssystem (500) zum Ermitteln eines Eindringobjekts.

6. Videokamera nach Anspruch 5, dadurch gekennzeichnet, daß:

das Bildeingabesystem (200) eine vorbestimmte Umwandlungsverarbeitung einer Eingabebildinformation, die in einem halben Zyklus einer Vibrationsperiode ermittelt wird, durchführt und verarbeitete Information über den Bildbus in dem Bildspeicher speichert; und

das Bildeingabesystem (200) aufweist:
einen A/D-Umsetzer (6) zum Umsetzen des vom Kamerakörper (1) ausgegebenen Bildsignals in ein digitales Signal; und
eine ITV-Schnittstelle (7) zum Übertragen des digitalen Bildsignals an den Bildspeicher (35).

7. Videokamera nach Anspruch 5, dadurch gekennzeichnet, daß:

das optische Flußermittlungssystem (300) eine einem entsprechenden Bereich zugeordnete Bewegung aus einer Vielzahl von vorher in dem Bildspeicher gespeicherten zeitseriellen Bildern entsprechend einer vorbestimmten Analyseverarbeitung ermittelt, um einen optischen Fluß des entsprechenden Bereichs zu ermitteln; und
das optische Flußermittlungssystem (300) folgendes aufweist:
eine Merkmal- und Ähnlichkeitsdetektorschaltung (310) zum Ermitteln von Merkmalen und Ähnlichkeitspunkten der Bilder; und
einen Merkmal- und Ähnlichkeitsermittlungsspeicher (350) zum Speichern des Ermittlungsprozesses und eines Ermittlungsergebnisses desselben.

8. Videokamera nach Anspruch 5, dadurch gekennzeichnet, daß:

das FOE-Meßschaltungssystem (400) Bewegungen eines Hintergrunds und eines Objekts analysiert, um einen optischen Fluß zwischen Bildern des Hintergrunds und des Objekts zu ermitteln, und einen FOE-(Dehnungsbrennpunkt-)Punkt mißt, in dem ein optischer Fluß eines stationären Objekts, das bei Bewegung einer Bildaufnahmeebene in einer Richtung einer optischen Achse aus einer Bewegungsvektorkette erzeugt wird, die durch Verbinden entsprechender Vektoren des optischen Flusses erzeugt wird; und
das FOE-Meßschaltungssystem (400) folgendes aufweist:
eine Linienermittlungsschaltung (42) zum Ermitteln von linearen Ausdrücken aus der Bewegungsvektorkette auf der Grundlage des optischen Flusses unter Verwendung eines vorbestimmten Verfahrens;
eine FOE-Berechnungsschaltung (44) zum Ermitteln von Schnittpunkten einer Vielzahl von durch lineare Ausdrücke dargestellten geraden Linien und Berechnen von Koordinaten des FOE-Punkts entsprechend einem vorbestimmten Verfahren; und
einen FOE-Speicher (46) zum Speichern der berechneten Koordinaten des FOE-Punkts.

9. Videokamera nach Anspruch 5, dadurch gekennzeichnet, daß:

das Eindringentscheidung-Schaltungssystem (500) festlegt, die Vielzahl von Bildern in ein Bild mit dem FOE-Punkt und ein Bild ohne FOE-Punkt zu trennen, um ein Eindringobjekt zu ermitteln; und
das Eindringentscheidung-Schaltungssystem (500) folgendes aufweist:
eine Entscheidungsschaltung (52) zum Bestimmen, daß die von dem FOE-Meßschaltungssystem (400) ermittelten Linien durch den FOE-Punkt laufen; und
einen Parameterspeicher (56) zum Speichern eines vorbestimmten Schwellwerts und des Entscheidungsergebnisses.

Revendications

1. Caméra vidéo comprenant:

un corps de caméra vidéo (1) comportant un élément de saisie d'image (20) pour saisir une information optique arrivant en incidence sur un système d'objectif (10); et
un moyen de génération de vibration (100), couplé mécaniquement audit élément de saisie d'image, pour appliquer une vibration audit élément de saisie d'image selon une course d'amplitude prédéterminée suivant une direction d'un axe optique et pour forcer ledit élément de saisie d'image à réaliser des opérations de saisie d'image au niveau d'une pluralité de positions,

caractérisée en ce que:

ledit moyen de génération de vibration (100) comprend:
une source de pilotage de vibration (70), couplée mécaniquement audit système d'objectif (10) ou audit élément de saisie d'image (20), pour appliquer une force de pilotage de vibration à au moins un élément pris parmi ledit système d'objectif et ledit élément de saisie d'image; et
un moyen de commande de source de vibration (73) pour appliquer un signal de commande prédéterminé à ladite source de pilotage de vibration afin de générer une vibration selon une période prédéterminée; et
ledit moyen de commande de source de vibration (73) comprend un circuit de commande d'actionneur; et
ladite source de pilotage de vibration (70) comprend un actionneur piézo-électrique;

ledit actionneur piézo-électrique étant constitué par deux structures bimorphes en porte-à-faux dont chacune est constituée par une pluralité d'éléments bimorphes pilotés en forme de S (71a-71f).

2. Caméra vidéo comprenant:

un élément de saisie d'image (20) pour recevoir une information optique d'un objet à photographier après que l'information optique a traversé un système d'objectif et pour réaliser une opération de saisie d'image;
un moyen de génération de vibration (100), couplé mécaniquement audit élément de saisie d'image, pour appliquer une vibration audit élément de saisie d'image selon une course d'amplitude prédéterminée suivant la direction de l'axe optique;
un moyen d'échantillonnage (22) pour extraire des signaux d'image selon des intervalles temporels prédéterminés à partir d'une pluralité de signaux d'image de différentes positions focales obtenus à partir dudit élément de saisie d'image pour une pluralité de positions à l'intérieur de la course; et
un moyen de mémoire d'image (35) pour stocker en série temporelle des images d'échantillonnage acquises à partir dudit élément de saisie d'image,

caractérisée en ce que:
ledit moyen de génération de vibration (100) comporte une source de pilotage de vibration (70) comprenant un actionneur piézo-électrique, ledit actionneur piézo-électrique étant constitué par deux structures bimorphes en porte-à-faux dont chacune est constituée par une pluralité d'éléments bimorphes pilotés en forme de S (71a-71f).

3. Caméra vidéo selon la revendication 2, caractérisée en ce qu'elle comprend en outre :
un moyen de prise de décision de focalisation (24) pour extraire une composante haute fréquence à partir d'un signal d'image de l'image d'échantillonnage, pour détecter une valeur d'évaluation de point focal pour évaluer un degré de focalisation suite à un traitement d'intégration, pour comparer les valeurs d'évaluation de point focal de la pluralité d'images et pour sélectionner une image d'échantillonnage présentant une valeur de précision de focalisation la plus importante.

4. Caméra vidéo selon la revendication 2, caractérisée en ce qu'elle comprend en outre :
un moyen de synthèse d'image (26) pour diviser l'image d'échantillonnage en une pluralité de zones en réalisant une détection de focalisation dans chaque zone divisée et en extrayant seulement des zones de focalisation à partir dudit moyen de mémoire d'image pour synthétiser les zones de focalisation selon une unique image.

5. Caméra vidéo selon la revendication 2, caractérisée en ce qu'elle inclut:

ledit système d'objectif (10) pour focaliser une information optique d'un objet à photographier ou similaire;
ledit élément de saisie d'image (20) pour réaliser des opérations de saisie d'image électrique;
ledit moyen de génération de vibration (100) pour faire vibrer ledit élément de saisie d'image lui-même ou une partie ou la totalité dudit système d'objectif selon une amplitude prédéterminée selon une période prédéterminée suivant une direction d'un axe optique;
un système d'entrée d'image (200) connecté audit moyen de génération de vibration pour réaliser un traitement de conversion d'information prédéterminé pour traiter une sortie d'image; et
ladite mémoire d'image (35) pour stocker la sortie d'image;
incluant en outre une CPU (90) pour commander le traitement d'image, un bus de commande (9) connecté à ladite CPU pour transmettre un signal de commande depuis ladite CPU et un bus d'image (8) pour transmettre une information d'image,
dans lequel ledit bus de commande est connecté à :
un système de détection de flux optique (300) pour détecter des caractéristiques et des points de similarité de l'image;
une mémoire de flux optique (65) pour stocker une information associée au flux optique pour un traitement de surveillance;
un système de circuit de mesure de focalisation d'extension, abrégé en FOE (400) pour mesurer un point FOE depuis lequel le flux optique d'un objet stationnaire dans l'image est généré; et
un système de circuit de décision d'intrusion (500) pour détecter un objet en intrusion.

6. Caméra vidéo selon la revendication 5, caractérisée en ce que:

ledit système d'entrée d'image (200) réalise un traitement de conversion prédéterminé d'une information d'image d'entrée obtenue lors d'un demi-cycle d'une période de vibration et stocke une information traitée dans ladite mémoire d'image par l'intermédiaire dudit bus d'image;

et
ledit système d'entrée d'image (200) comprend:
un convertisseur analogique-numérique (6) pour convertir le signal d'image émis en sortie depuis ledit corps de caméra (1) selon un signal numérique; et
une interface ITV (7) pour transmettre le signal d'image numérique à ladite mémoire d'image (35).

7. Caméra vidéo selon la revendication 5, caractérisée en ce que:

ledit système de détection de flux optique (300) obtient un déplacement associé à une zone correspondante parmi une pluralité d'images en série temporelle pré-stockées dans ladite mémoire d'image en conformité avec un traitement d'analyse prédéterminé afin d'obtenir un flux optique de la zone correspondante; et
ledit système de détection de flux optique (300) comprend:
un circuit de détecteur de caractéristique et de similarité (310) pour détecter des caractéristiques et des points de similarité des images; et
une mémoire de détection de caractéristique et de similarité (350) pour stocker le processus de détection et son résultat de détection.

8. Caméra vidéo selon la revendication 5, caractérisée en ce que:

ledit système de circuit de mesure FOE (400) analyse des déplacements d'un fond et d'un objet afin d'obtenir un flux optique entre des images du fond et de l'objet, et mesure un point FOE (focalisation d'extension) au niveau duquel un flux optique d'un objet stationnaire obtenu suite à un déplacement d'un plan de saisie d'image suivant une direction d'un axe optique est généré à partir d'une chaîne de vecteurs de déplacement obtenue en connectant des vecteurs correspondants du flux optique; et
ledit système de circuit de mesure FOE (400) comprend:
un circuit de détection de ligne (42) pour obtenir des expressions linéaires à partir de la chaîne de vecteurs de déplacement sur la base du flux optique en utilisant un procédé prédéterminé;
un circuit de calcul FOE (44) pour obtenir des intersections d'une pluralité de lignes rectilignes représentées par les expressions linéaires et pour calculer des coordonnées du point FOE conformément à un procédé prédéterminé; et
une mémoire FOE (46) pour stocker les coordonnées calculées du point FOE.

9. Caméra vidéo selon la revendication 5, caractérisée en ce que:

ledit système de circuit de décision d'intrusion (500) décide de séparer la pluralité d'images selon une image comportant le point FOE et une image ne comportant pas de point FOE afin de détecter un objet en intrusion; et
ledit système de circuit de décision d'intrusion (500) comprend:
un circuit de décision (52) pour déterminer que les lignes obtenues par ledit système de circuit de mesure FOE (400) passent par le point FOE; et
une mémoire de paramètre (56) pour stocker une valeur de seuil prédéterminée et le résultat de décision.

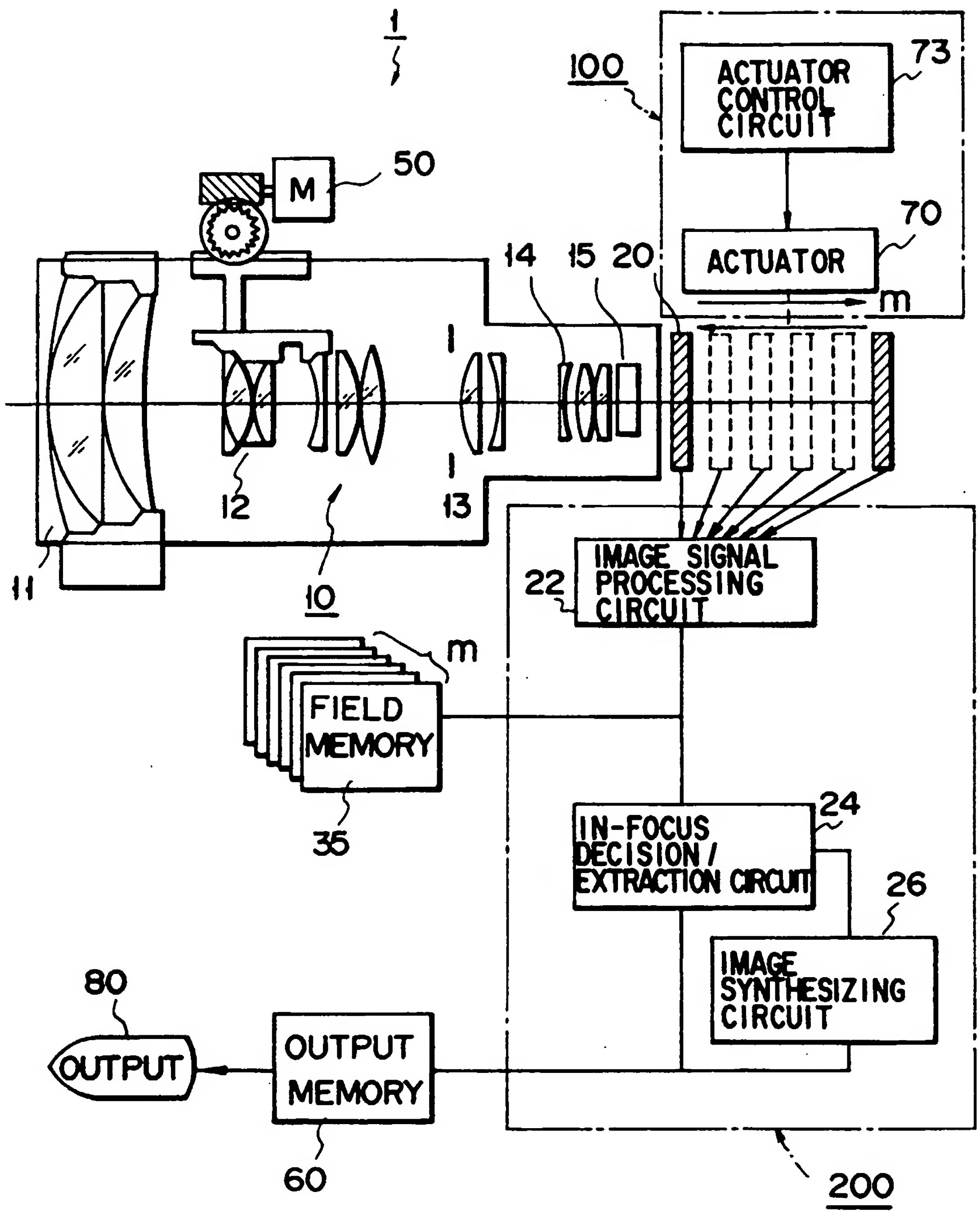
1
100
ACTUATOR CONTROL CIRCUIT
73
M
50
70
ACTUATOR
14
15
20
m
12
13
11
10
22
IMAGE SIGNAL PROCESSING CIRCUIT
m
FIELD MEMORY
35
IN-FOCUS DECISION / EXTRACTION CIRCUIT
24
26
IMAGE SYNTHESIZING CIRCUIT
80
OUTPUT
OUTPUT MEMORY
60
200

FIG. 1

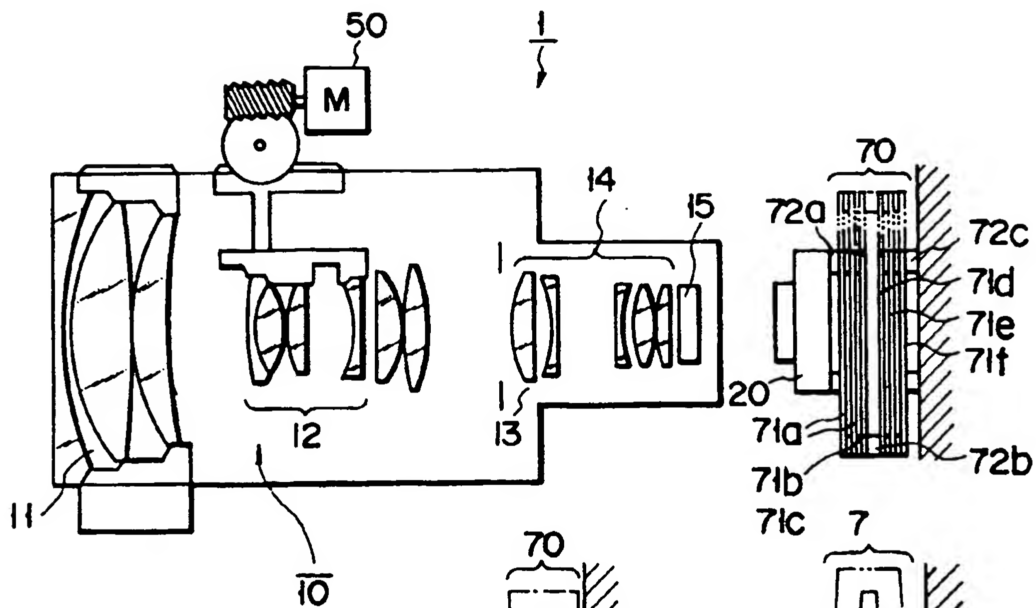

FIG. 2A

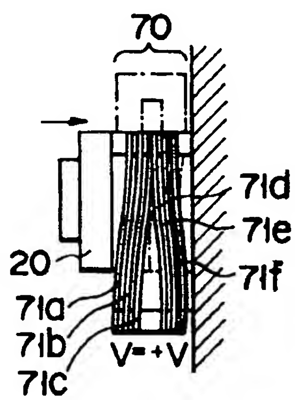

FIG. 2C

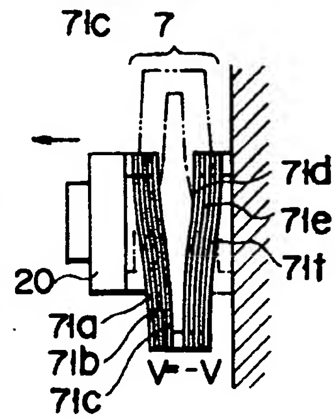

FIG. 2B

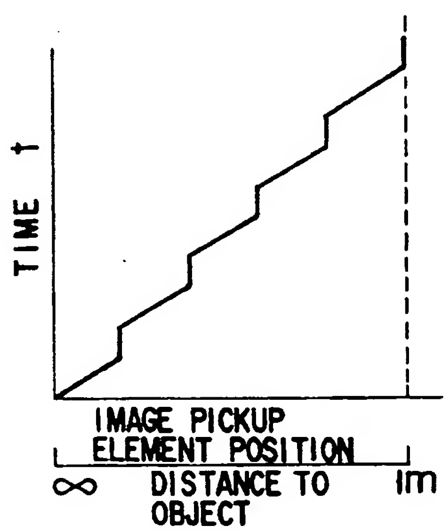

FIG. 3

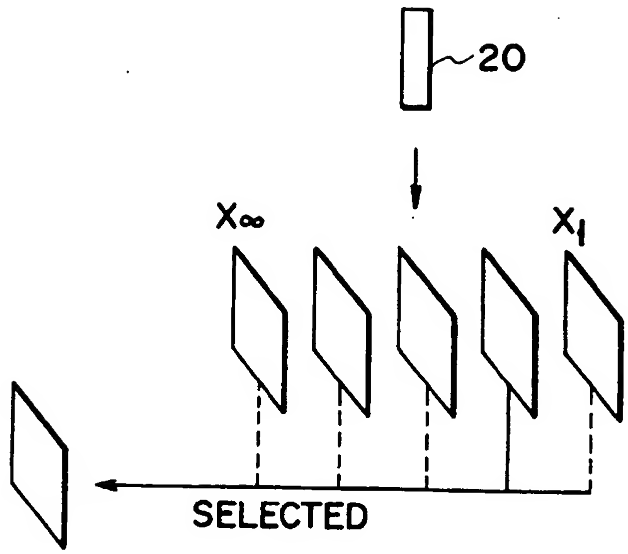

FIG. 4A

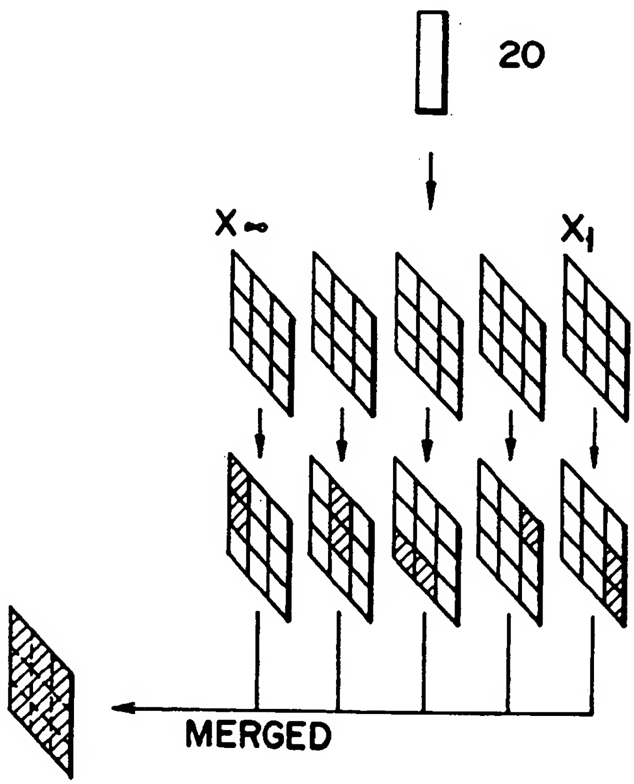

FIG. 4B